Communications Research Centre Canada
Centre de recherches sur les communications Canada

Eye on Technology

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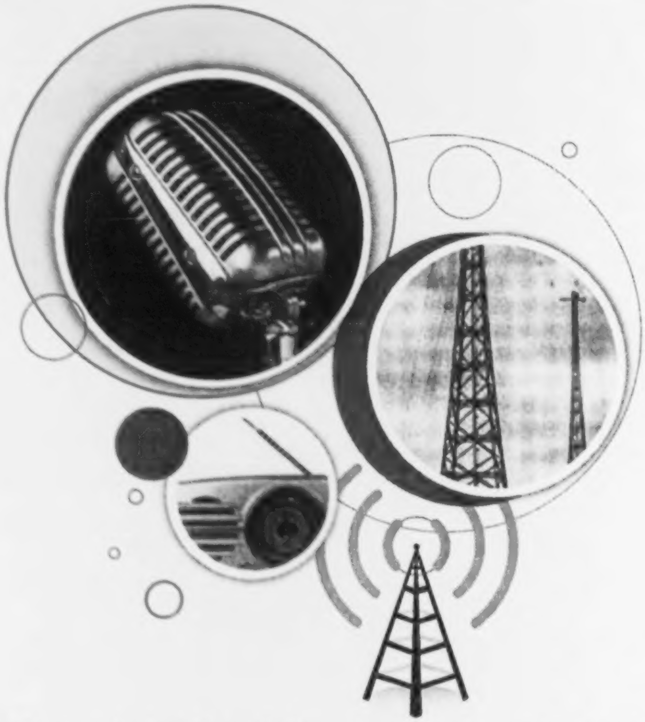
CRC advises government & industry on HD radio



The Communications Research Centre has finalized a year-long research study on hybrid digital (HD) radio which will help broadcasters, policy makers and regulators evaluate the technical feasibility of this new technology for Canadian markets.

The results will provide the study's sponsors, Industry Canada and the Digital Radio Co-ordinating Group (DRCG), with a much clearer picture on any inference issues between FM in-band on-channel (IBOC) digital services and regular analog FM services operating on adjacent channels.

FM-IBOC isn't currently available in Canada; Industry Canada announced in October that it would begin accepting applications for experimental FM-IBOC transmissions. The Canadian Radio-television and Telecommunications Commission said it would be prepared to adopt an expedited licensing process for stations.

"Now that FM radio stations have been invited to experiment with HD Radio, CRC's ongoing efforts in evaluating this in-band digital technology will provide the DRCG with important data. We anticipate that this information will assist broadcasters in determining whether the new service opportunities presented by this technology will outweigh any impact on their existing analog services," says DRCG Chair Wayne Stacey.

HD radio allows existing analog stations to add-on a digital transmission component, which can provide multiple channels of programming on the same frequency without requiring additional spectrum. The technology also accommodates other features such as scrolling text and graphics content, as well as real-time traffic updates. HD radio is widely available in the United States through more than 1,500 AM and FM radio stations, although it hasn't enjoyed the level of commercial success many had anticipated.

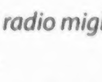
CRC's Radio Broadcast Systems and Transmission Group is recognized worldwide for its industry leadership in the field of digital radio broadcasting, helping to position Canada as a global authority in this field. Its expertise extends to L-Band digital radio, Digital Multimedia Broadcasting and, more recently, FM-IBOC.

"Due to our in-depth expertise, we've been able to develop some effective methodologies to address those test issues which we felt were weakly considered in the past. We see our work as complementing what others have done in both Canada and the United States," says André Carr, Project Leader of the Radio Broadcast Systems and Transmission (RBSC) group.

Government and industry often turn to CRC when they require objective technical advice on new technologies – advice that assists in the development of new policies, regulations and standards for efficient and effective regulation and allocation of radio spectrum.

"One of the main advantages to using CRC is that we're an impartial third party," explains René Voyer, Research Manager with CRC's RBSC group. "As a non-commercial and independent research agency, we can provide advice that is used by both the public and private sectors to make informed decisions about new technologies."

"The CRC has been a valued member and contributor to the work of the Digital Radio Co-ordinating Group since the early 1990s. We have depended greatly on the engineering expertise and resources that CRC personnel have been able to contribute during our assessments of all forms of digital radio broadcasting, from our early work evaluating L-Band digital radio, and more recently in considering the opportunities that Digital Multimedia Broadcasting and FM-IBOC digital radio might create for Canada's broadcasters."



Wayne Stacey, P.Eng
Chair, Digital Radio Co-ordinating Group

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Why Canada needs independent testing

In this current study, CRC collaborated with the Canadian Broadcasting Corporation, Industry Canada's Spectrum Engineering group and Certification and Engineering Bureau, as well as Mexico's National Chamber of Radio and Television Industries (CIRT) to better predict how FM-IBOC will operate in Canadian FM radio markets.

The U.S. has studied FM-IBOC extensively, but as Carr explains, many of those results cannot be directly applied to Canada, essentially due to our different spectrum and licencing regulatory framework.

The CRC set out to conduct independent research specific to the Canadian environment. Its laboratory testing over the past year examined HD radio's basic service mode MP1 with three main objectives in mind.

One goal was to validate an upgrade to the CRC-COVLAB* – a scientific modeling software that predicts and analyzes coverage areas for various types of over-the-air communications systems. The software is widely used in government labs and engineering firms worldwide.

The CRC team had initially developed a module for the software using early technical data generated in the US to more accurately predict IBOC signal coverage and quantify the level of interference those digital transmissions will have on neighbouring analog or IBOC channels in this country. Data from field tests using an experimental transmitter the CBC had installed in Toronto in the fall of 2006 provided additional data which, combined with the current lab results, are enabling CRC to refine the IBOC module.

The second objective was to analyze the impact of FM-IBOC on existing analog FM radio signals. With so many American FM-IBOC stations so close to the Canadian border, radio stations in this country are concerned about possible interference effects. Thirdly, the team studied the overall performance of the digital FM-IBOC signal: how far does the add-on transmission reach and what service expectations can a broadcaster expect from this technology.

Carr says that the test results are being reviewed by Industry Canada and the DRCG. He did note that there are both advantages and disadvantages to the technology that would have to be considered by industry and regulators before deciding on FM-IBOC's future in Canada.

For more information on the FM-IBOC study, please contact André Carr, Project Leader, Radio Broadcast Systems and Transmission group at (613) 991-5366 or by e-mail at *andre.carr@crc.ca*.

CRC leverages satcom to improve lives of northern Canadians

For most Canadian businesses, municipalities, schools and homes, broadband Internet is as common as electricity. But for the 460 residents of Fort Severn – Ontario's most northern community – the technical and financial barriers seemed prohibitive.

That was until the Communications Research Centre partnered with Telesat Canada in 2000 to install and test four satellite sites on behalf of K-Net, an Industry Canada-funded Aboriginal SMART Community. CRC staff also trained and mentored local personnel on how hybrid satellite networks are installed and maintained.

Today, as a result of that pioneering work, K-Net is providing leading-edge telecommunication infrastructure and application support to over 70 First Nations and Inuit communities in Ontario, northern Quebec and northern Manitoba.

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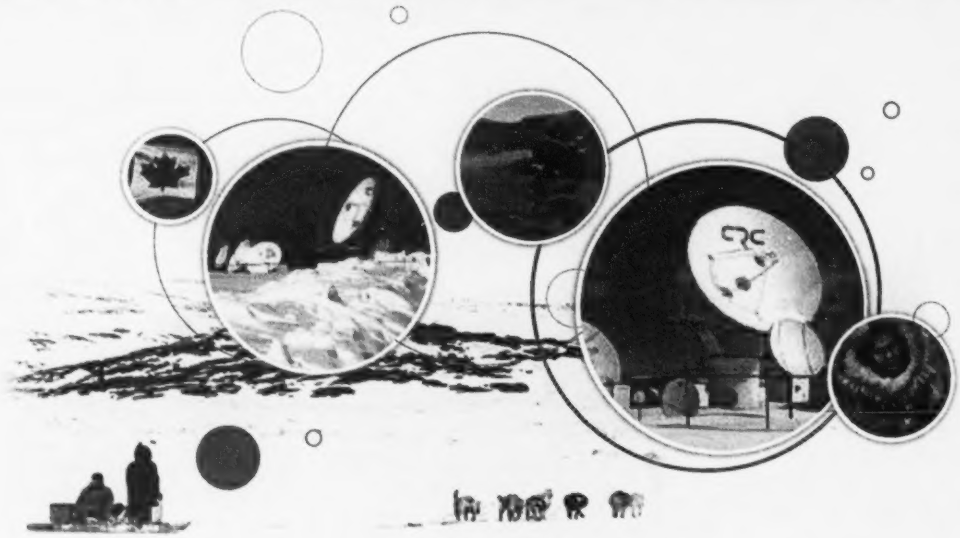

It was a similar experience for OmniGlobe Networks Inc. The Montreal-based company, which provides satellite and wireless broadband services to regions of the world where terrestrial telecommunications are unavailable, expensive or unreliable, is currently deploying cellular phone service to northern Canada using a satellite backhaul technology developed in partnership with CRC.

It's a story that has been repeated across northern Canada, including the Arctic, which is a key focal point in the government's efforts to strengthen Canadian sovereignty, protect the region's environmental heritage, promote economic and social development, and improve and devolve governance.

Having an advanced communications infrastructure in place is critical to achieving these goals. And, while satellite is the only practical alternative for reaching remote northern communities, the bandwidth is expensive and technical hurdles can be significant. It takes highly specialized technicians to make these applications work on a satellite system and to integrate the satellite delivery with a terrestrial network located elsewhere in Canada.

Fortunately, Canada has CRC – one of the few clusters of national expertise in satellite communications.

"CRC steps in where there is no business case for private companies," explains Claude Bélisle, Vice-President of CRC's Satellite Communications and Radio Propagation Research Branch. "We are a national resource that is available to other government departments, and to industry and the academic community, to test new hardware or to prove whether a network design concept will work with the application they have in mind."

Delivering tele-health, tele-education or other applications in northern regions is a complex undertaking. Extreme cold, power availability and repairs time are a few of the issues installation crew are facing. However, satellite service is often the only means to connect the northern regions to the south.

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As Christopher Iles, Supervisor of Network Systems Integration for the satcom branch, explains, it's also not practical for a partner to spend tens of thousands of dollars on a spectrum analyzer, signal generator and other test equipment to find out if their application will work.

"That's where we come in. We have the equipment. We have the expertise and we have a fairly good idea of what will work and what won't because we've dealing with satcom for so long," says Iles.

CRC also finds ways to minimize satellite costs by maximizing bandwidth usage. Rather than using an entire satellite channel to provide a service that takes up only a fraction of the available capacity, CRC works with partners to bundle several applications onto the same pipe.

"If Health Canada is providing a tele-health service, CRC can help them block the bandwidth they need during the day. Then we can go to Natural Resources Canada, for example, and have them transfer mining data down south at night," says Iles. "With satellite bandwidth, you pay for it whether you use it or not, so our goal is to ensure the most efficient use of that bandwidth."

For more information on how your department, organization or company can partner with CRC, please contact CRC Project Manager Jim Hamilton at (613) 998-2717. Additional information on CRC's satcom programs can be found at: *http://crc.ca/en/html/crc/home/research/satcom/major_satcom*

Canada-Finland tests underway on LTCC

Technology opens door for cost-effective applications at higher frequencies

CRC researchers are working with colleagues in Finland to study the advantages – and the challenges – of using a ceramic-based technology to reduce the cost of producing complex electrical components for high-frequency wireless applications. And, so far, the results look promising.

CRC in Northern Canada

Remote Assertive Community Homecare (REACH) Program: CRC and Health Canada demonstrated that satellite-delivered tele-psychiatry can reduce travel costs for nurses by 20-30%.

SMART Labrador: CRC planned, deployed, tested and maintained satellite access across Labrador to enable the delivery of tele-health, tele-justice, tele-education, e-Government, e-Commerce and Internet access.

Haughton Mars Project: In this joint project with the Canadian Space Agency, NASA and the European Space Agency, CRC has installed a satcom system on Devon Island in Nunavut to study space-based communications in a remote and hostile environment, in preparing for a human expedition to Mars. CRC is a major partner in the project, providing testing and advice on the main space-based links.

CANARIE Network: CRC enables government and university labs to uplink their data from this national research testbed to a satellite to reach northern Canada and other remote areas of the country.

Multimedia Connectivity: This year, CRC, Telesat Canada and Canadian Space Agency are working with the Yukon, Northwest Territories and Nunavut governments to deploy Ka-band satellite terminals in selected communities for high-speed multimedia connectivity.

CRC's Satcom Expertise

- Modulation, coding and multiple access techniques
- Systems analysis and design
- Earth terminal design, prototyping
- Test bed capable of accessing virtually all visible satellites
- Program/project management experience

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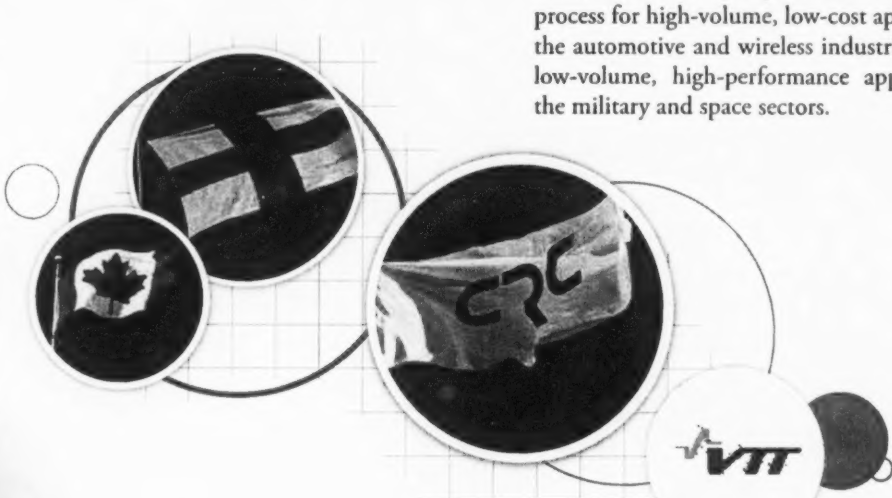
Known as Low Temperature Cofired Ceramic (LTCC), this durable and cost-effective platform has been widely used to package integrated circuits for a variety of applications, including opto-electronics, automotive and medical. In collaboration with the VTT Technical Research Centre of Finland, CRC engineers are examining how LTCC can be applied to high-frequency wireless components, from antenna modules to transmitters, power amplifiers and filters.

"The success of the collaboration owes much to the complementary nature of VTT's and CRC's expertise, objectives and research interests with VTT focusing its efforts on the development and refinement of its LTCC fabrication capability and CRC on the design, application and RF characterization of the technology", says Dr. Valek Szwarc, Research Manager of CRC's Integrated Electronics Research Group.

From humble beginnings to high-level integration

LTCC has been around for about 20 years and was used primarily in the early days to produce high-volume, low-frequency microwave devices. It started as a ceramic-based packaging technique in which simple integrated circuits were packaged and mounted onto a printed circuit board. However, as subsystems became more complex, the need grew for a packaging approach that allowed for higher levels of integration and miniaturization.

LTCC provided a solution. Its excellent electrical and mechanical properties, combined with high reliability, stability and the ability to make three-dimensional integrated microstructures, made it ideal for meeting the demands of higher levels of integration, while allowing mass manufacturing at a reduced cost. Today, LTCC is an established process for high-volume, low-cost applications in the automotive and wireless industries as well as low-volume, high-performance applications in the military and space sectors.



Advantages of LTCC

- high performance packaging for high-frequency devices
- cost efficiency for high volumes
- high reliability and stability
- ability to make 3D integrated microstructures
- can accommodate embedded passive components

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LTCC allows several integrated circuits along with other components and functions such as power conditioning and signal routing to be housed onto one multi-layered ceramic module. For example, you can have electrical signals being received on one package level, the transmission happening on another, and power supplies and control lines working on other levels to form a compact three-dimensional module. The result: complete wireless solutions embedded in a small ceramic package.

CRC aims to expand LTCC's capabilities

How many levels or layers can LTCC accommodate? "It's almost limitless," says Dr. Szwarc. "You start by cutting out the appropriate shape for the first layer with cavities or holes to accommodate electrical components and vertical interconnections. You then define any metal traces needed for electrical connectivity, and then repeat the process again and again until enough layers have been defined to form a complete 3D structure."

The layers are then carefully aligned and heated to the relatively low firing temperature of 850 °C, which makes it possible to co-fire the embedded components (e.g. resistors, capacitors and inductors) with low resistive metals such as silver, gold and copper. In contrast, High temperature Cofired Ceramic (HTCC) technology uses the higher resistive metals molybdenum and tungsten.

"The embedded components effectively become buried structures after firing," Dr. Szwarc explains. "The end result is a three-dimensional module that is significantly smaller than what is produced using other conventional approaches."

LTCC is widely used in the communications industry for lower microwave frequency applications, but applying it to the higher microwave frequencies isn't that simple. It's a challenge CRC engineers are working to solve.

One problem is that lower frequency signals travel horizontally on each layer. With high frequency signals, you need to be able to control horizontal movement on a specific layer as well as vertical movement between layers. The CRC team is examining how this can be done with minimal degradation of signal quality (reflection and loss). It's a difficult task as high frequency signals prefer to travel undisturbed once they have been launched. High frequency circuits demand tighter line tolerances than low frequencies and, therefore, access to state-of-the-art LTCC processes can be very useful.

With help from their Finnish partners, the CRC team is making significant progress. VTT provides access to a variety of LTCC processes which is allowing CRC to gain insight into their different characteristics and suitability for high frequency application.

So far, CRC has successfully demonstrated a 30 GHz LTCC communications module that not only includes the electronics but also patch antenna structures integrated into the lid of the package. This concept is now being developed for 60 GHz applications such as point-to-point communications and high data rate wireless LAN applications. Plans are also in place to explore frequencies above 60 GHz as part of the collaboration with VTT.

The results, so far, indicate that LTCC has a promising future as an advanced high frequency packaging technology for communications modules.

For more information on CRC's research program in LTCC technology, contact Dr. Valek Szwarc, Research Manager, Integrated Electronics Research Group (Tel: (613) 998-2089, email: *valek.szwarc@crc.ca*).

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CRC brings physical sound *to the 3D virtual world*

CRC has found an easy-to-use and inexpensive way to navigate and manipulate soundscapes for complex virtual worlds using a 25-year old protocol called Musical Instrument Digital Interface (MIDI).

Widely used and adopted early by musicians, MIDI is a general purpose technology that enables electronic musical instruments, computers and other equipment to communicate, control and synchronize with each other. An electronic keyboard with a built-in MIDI interface sells for as little as $150.

CRC researcher John Stewart, a musician himself who has used MIDI and digitized sound extensively over the years, identified the potential of taking off-the shelf, plug-and-play MIDI devices and adapting their use for 3D environments. As a result, John developed MIDI's capabilities into a platform technology that could be the next breakthrough. To date, no scheme has been widely accepted by the user community.

If all goes as expected, this Communications Research Centre-developed technology could also become a new world standard for use in many sectors that require high-end 3D visualization, simulation and modeling. They include architecture, oil and gas exploration, aerospace, healthcare, training, public safety and entertainment.

"MIDI is essentially a complex computer network that works in real time. It can control sound, movement, lightening, anything – it's all data to MIDI. For developers, it offers a new platform for creating and manipulating 3D worlds. For users, it can make what you see and experience far more realistic," explains Stewart, Team Leader, Networked Media Laboratory at the CRC's Network Systems and Technologies group.

Such capabilities would certainly be of interest to many sectors. The automotive industry, for example, already marries computer automation design (CAD) and virtual reality to reduce the time needed to design, engineer and manufacture a new automobile. In the healthcare sector, virtual reality makes it possible for high-resolution CT scans, MRIs and ultrasounds to produce detailed 3D images of a patient.

CRC's technology also tackles another major hurdle in next-generation virtual reality – keeping it affordable. "What we have designed is inexpensive and configurable control into and out of a virtual world," he adds. "Instead of a technician taking a day to set up complex input/output devices, with our technology you can simply buy an off-the-shelf keyboard at Costco, come home, plug it in and you are ready to go."

Another major advantage to using MIDI is that it's an international standard. Stewart hopes the International Standards Association (ISO) will make CRC's interface part of the MIDI and X3D standards. X3D holds great promise for many applications.

What is "Physical Sound"?

Led by Stewart, a CRC team of cognitive and computer scientists developed an open source programming code – tentatively called *Physical Sound* – that maps a physical sound environment by expanding MIDI's capabilities as a platform technology.

Stewart demonstrated how the technology can bring life-like sound to a virtual 3D world in real-time simply by using a 20-year-old music keyboard linked to a PC via a USB cable. The interaction works both ways: when Stewart clicked on a ball in the virtual world, a note sounded on the music keyboard.

"You push a key or move under a sensor, information is transmitted. That information can trigger a sound, control the brightness of a virtual scene, change colours or make things move."

In another demonstration, Stewart designed a "living" virtual town square, where each digital sound changes as an object or avatar moves through a scene. For example, the ringing from a bell grows fainter as the object moves further away; an echo can be heard as the user moves closer to a brick wall; and, the sound will appear to be coming from different directions depending on where the user is positioned. "MIDI is used for manipulating the sounds you hear; MIDI does not care whether the sound samples are those of a Stradivarius violin or of a water fountain, so we use sounds that compliment the virtual reality that you see on this computer screen."

The team is also experimenting with ultrasonic sensors to spatially map human movement in the laboratory. "You can use physical movement tracked by a sensor to send messages to a MIDI network. That data are then translated into sound or music in a virtual world."

Physical Sound is built on another CRC-developed open source software called *FreeWRL*, which is widely used internationally and may well be the fastest browser available for virtual worlds.

Beta testing globally

The next step is to beta test the MIDI interface with the global user community where software developers, academics and computer programmers can experiment with it, suggest improvements and expand its use across many domains. Users can download node definitions, the computing code and test results at *http://freewrl.sourceforge.net*. Once the MIDI interface is more fully developed, it will be submitted to the ISO as an addition to the X3D standard.

"John's team has provided a vital missing link in the marriage of X3D and music – a marriage some have predicted would be one of the most productive, exhilarating relationships in the emerging field of real-time 3D systems."

Source: *http://3donthewebcheap.blogspot.com*

A technical paper on *Physical Sound* – titled Binding External Interactivity to X3D – was accepted last year at the International Conference of 3D Web Technology in Italy. For a copy, contact John Stewart at *alex.stewart@crc.ca*.

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LICENSING CORNER

CRC wins OCRI Award for Technology Commercialization

The Communications Research Centre (CRC) received the 2008 OCRI Award for Technology Partnership Commercialization at the OCRI Awards Gala on April 3, 2008.

This award is testament to CRC's technology transfer expertise and its ability to turn research into commercial opportunities. The CRC is well known for its strength in the areas of Bragg gratings, Software Defined Radio, Coverage Prediction and Forward Error Correction. For more information on these and other technologies developed by CRC, see the Hot Technologies site at crc.ca.

For a complete list of award winners visit OCRI's web site (*www.ocri.ca*).

CRC's Most Popular Technologies and Areas of Expertise

Software Defined Radio (SDR)
- A radio that provides software control of a variety of modulation techniques and waveform requirements, of current and evolving standards, over a broad frequency range.

Optical communications
- Fiber Bragg Gratings: Portfolio of patents covering the Fiber Bragg Gratings manufacturing process.

CRC-SEAQ
- Suite of patented software for the objective and subjective testing of audio quality.

CRC-COVLAB
- Advanced simulation software that performs coverage prediction for various types of communication systems in order to design and optimize networks of transmitters, analyze interference problems and explore new coverage scenarios.

CRC-COVLITE
- Sophisticated path loss estimation tool for single transmitter coverage prediction.

Video processing technologies
- Frame-rate conversion software.
- Video-quality assessment.

Antenna technologies
- A range of planar and flat-plate antenna technologies protected by patent and trade secret for use in wireless communications applications. Supported by a world-class antenna design group.

Forward Error Correction (FEC) technology
- Extremely fast FEC simulation tools for 16-state TurboCodes, yielding throughputs of over 1 Mbps on current PCs.
- Innovative interleaving techniques for TurboCodes that yield excellent error flare performance.
- HyperCodes and SkewCodes (families of enhanced turbo product codes developed at CRC).

CRC-PREDICT
- VHF/UHF Propagation Prediction Program used for estimating radio signal strengths on terrestrial paths at VHF and UHF.

Linearization of power amplifiers
- Type-based baseband predistorter function estimation technique for nonlinear power amplifiers.

Wireless terminal technologies
- Broadband wireless point-to-point and point-to-multipoint technologies.

CRC's mission is to be the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes. CRC also aims to help identify and close the innovation gaps in Canada's communications sector by:

- *engaging in industry partnerships;*
- *building technical intelligence;*
- *supporting small and medium-sized high technology enterprises.*